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The second year of the project allowed major tasks to be completed in the evolution of the advanced technology required for this project. A continual interchange of concepts and technology was made possible by the coordination of the three projects of the University Initiative Program at Hahnemann University (Dr John Chapin) and at Bowman Gray Medical School (Dr Samual A. Deadwyler). The goal was to evolve a system for acquisition of a large ensemble of neuron spike trains from connected brain regions in awake behaving rats. Summary: Overall, the three projects have created a foundation of new methodology to promote the next decade of research on large-scale recording of ensemble neuron spike trains. We intend to apply these capabilities to studies of neural circuit models of cognition and long term responses to stress. The experimental aims of the project will be considered exclusively in the third year.

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PROGRESS REPORT

Project Title: Neostriatal Neuronal Activity and Behavior

P.I.: Donald J. Woodward, Ph.D.

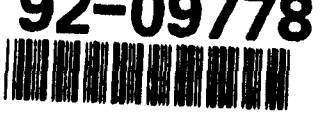
Granting Agency: Air Force Office of Sponsored Research (AFOSR)

The second year of the project allowed major tasks to be completed in the evolution of the advanced technology required for this project. A continual interchange of concepts and technology was made possible by the coordination of the three projects of the University Initiative Program at Hahnemann University (Dr. John Chapin) and at Bowman Gray Medical School (Dr. Samual A. Deadwyler). The goal was to evolve a system for acquisition of a large ensemble of neuron spike trains from connected brain regions in awake behaving rats. Phases of work with notable progress include the following.

1) **Probe Arrays** - A major obstacle overcome was the construction of microwire probe arrays. Dr. Gerald Bylander and his technical assistant, Mr. Lawrence Andrews, devised methods for assembly of a number of configurations of microwire arrays. These are now surgically implanted into regions where recordings of spike trains are to be made. The most useful array configurations are either simple bundles of eight wires or two rows of eight wires separated by 80 micron spacing. The ends of the wires are trimmed and cleaned before surgery and recordings of neurons made during implantation. These arrays have now allowed successful concurrent recordings of up to 46 neurons in thalamus and SI-MI cortex and 30 neuron spike trains in neostriatum.

2) **Data Acquisition** - Instrumentation was completed to allow 48 signals to be carried from a plug assembly on the rat's head to a 64 channel amplifier and spike sorter system constructed by Spectrum Scientific (Mr. Harvey Wiggins) in Dallas. The multiple DSP system allows concurrent sorting to be done on eight spike trains per DSP. A Windows-PC interface has been devised to allow facile operator control of the sorting algorithm. Progress on this phase of work was boosted considerably when Mr. Wiggins was awarded a Phase II SBIR grant to complete development of the Spike Sorter System.

3) **Data Acquisition Workstation and Analysis Software** - We have worked with Dr. S. A. Deadwyler at Bowman Gray Medical School to define an acquisition system based on a multiprocessor VME bus system. We are now able to acquire data from five chambers concurrently and control an experimental chamber by regulated stimulus presentation and recording behavioral responses. We have upgraded all of our experimental control systems to deal with the next decade of brain research requiring real time computation. Analysis software has been expanded by Dr. Chapin to deal with needs of the three laboratories. Script language commands allow automated computation and graphical display of the ensemble spike trains. The time required for such analysis has been reduced by an order of magnitude. Systematic analysis activity of ensembles around time nodes is now possible, as well as large scale cross correlogram computation for testing of linkages.



4) **Modelling of Neostriatal Circuitry** - We have continued an investigation of computational properties of local feedback circuits in neostriatum (Kirillov, Myre and Woodward, 1991 Neuroscience Abstracts). We previously noted a mode of reciprocal on-off switching within the local feedback system. We have since discovered that local domains of medium spiny neurons project 50% of outputs to substantia nigra reticulata and the other 50 to globus pallidus external segment. This arrangement is what we predicted from simulation would be needed to function as a short term memory of scalar intensity values. We are now preparing these results for publication.

5) **Neostriatal ensemble Recording** - All components of the system were installed as of December 1991 and this has allowed true ensemble recording to be achieved. Data collection is now increased two orders of magnitude. We have obtained data sets from 24 neostriatal neurons during three-hour recording sessions. In these rats 6-OHDA was used to destroy the DA system unilaterally. Injection of L-dopa restored rotatory motor behavior and evoked pronounced global changes in the activity in the ensemble of neurons. Data collected in a single day previously would have required two months of sustained experimental effort in previous methods. We intend to exploit these advances in year three of the project to be conducted at the new laboratory location at Bowman Gray Medical School.

Summary: Overall, the three projects have created a foundation of new methodology to promote the next decade of research on large-scale recording of ensemble neuron spike trains. We intend to apply these capabilities to studies of neural circuit models of cognition and long term responses to stress. The experimental aims of the project will be considered exclusively in the third year.